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COMMUNICATION FEASIBILITY STUDY FOR SMART GRID WITH ADVANCED METERING INFRASTRUCTURE

AVANI PUJARA, GEETA VELHAL, S. M. BAKRE & V. MURALIDHARA

Jain University, Bangalore, Karnataka, India

ABSTRACT

This paper provides an overview of the communication infrastructure requirement for the Smart grid. Advanced Metering Infrastructure (AMI) is the most important parameter of a complex power grid. Paper summarizes various technologies and architecture for smart grid. IP based protocol hierarchies is explained. It also gives an idea about android based platform along with AMI for remote monitoring and control. Use of AMI improves system efficiency, provides intelligent outage management system, enhancedustomerservice, two way communication, real time monitoring of system stability and hence improves the reliability of the system.

KEYWORDS: Advanced Metering Infrastructure (AMI), Outage Management System (OMS), Reliability, Intelligent Grid, Android Based Platform

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INTRODUCTION

Intelligent grid is next generation power grid, and it is also known as Smart Grid. A smart grid is an integration of information and communication technologies into conventional transmission and distribution system. Drivers of smart grid are increase in Electricity demand and supply short fall, loss reduction, managing human element, reliability, renewable energy integration and technological advancement. A smart grid embrace new technologies i.e. telecommunication, control, self -healing, efficiency, reliability and security of power systems. A communication infrastructure is most important part to the success of grid intelligence. Various smart grid technologies already been used by power sector of India are smart metering, Automatic Meter Reading (AMR), SCADA system, GIS mapping and load forecasting.

AMI is the strong carrier for harmonious relationship of power supply in smart grid [1].AMI allows faster outage detection and restoration of service. It also provides customer with greater control over their electricity usage. AMI contains many devices like data management centre master station communication center, intelligent terminal and smart meter. Among them smart meter is the key component of the advance metering infrastructure. Wireless communication plays vital role in smart grid, Advancement in GSM technology have made it possible to get all real time application in smart grid environment. AMI smart meters equipped with Power Quality (PQ) monitoring capabilities enable more rapid detection, diagnosis and resolution of PQ problems. Operationally, with AMI the utility knows immediately when and where an outage occurs so it can dispatch repair crews in a more timely and efficient way. Meter-level outage and restoration information accelerates the outage restoration process, which includes notifying consumers about when power is likely to return.

AMI Overall Design [1]

Advanced metering infrastructure is divided into four layers. First layer is master station which data management center, communication management center and power user prepaid management center. The second layer is to provide channels for communication from master station to smart meters, which gives two way communications. At present in India PLC, RF, GPRS and GSM technologies are used for second layer of advanced metering infrastructure. Third layer is smart meter which realizes energy metering, real time prizing, prepaid function, outage management, vender record and report, power quality monitoring, data acquisition and storages.

The forth layer is indoor intelligent terminal. Smart display terminal can read report and inform about fault and maintenance. [1]

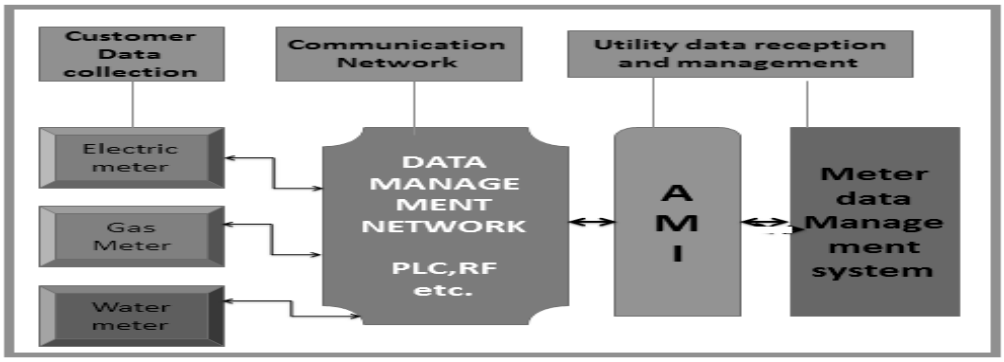

Figure 1: Communication Network of AMI

AMI and OMS

OMS allows a utility to better manage power outages and restoration events as well as reduce outage duration and costs. Smart meters allow the utility to better understand if the outage is related to the utility service or is related to a problem within the customer's premises. The utility can then take the proper action to resolve the problem in a timely and cost effective manner. By gathering data from smart meters, utilities can quickly locate and repair utility-side problems. An AMI system must tie into a utility's OMS in order to support two-way communications regarding outages and restorations. By providing utilities with relevant, actionable information, a modernized AMI helps focus and accelerate utility staff response and avoids overwhelming the OMS. Proper design of the system integration between AMI and OMS can improve performance of distribution management system[2] Figure 2 outlines the system and process integration of AMI and OMS.

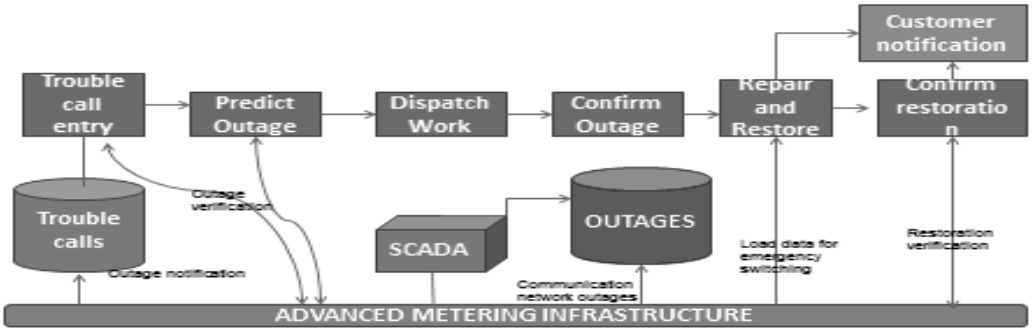

Figure 2: An Integration of AMI and OMS

SMART METER

Smart meter is an electronic device that records consumption of electrical energy in small intervals of time and communicates the information to utility for monitoring and billing purpose. It enables two way communications. Figure 3 shows the block diagram of the numeric meter. Signals from CT and PT are sampled after passing through anti-aliasing filter. Higher frequency components contained within the sampled waveform may not only fail to be identified due to the actual sampling rate and the computational algorithm applied, but may also be falsely represented as a lower frequency component. The effect of a high frequency component in a sampled ac waveform that appears as a low frequency signal is called aliasing [3].

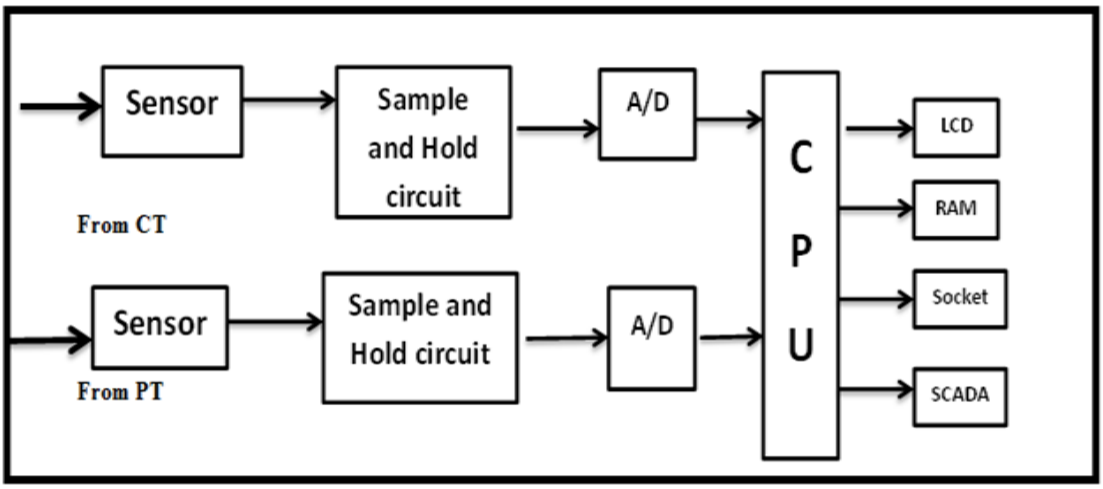

Figure 3: Block Diagram of the Numeric Meter. [4]

Sampling is the process of converting a continuous time signal, such as a current or voltage, to a discrete-time signal. Following diagram represents sampling.

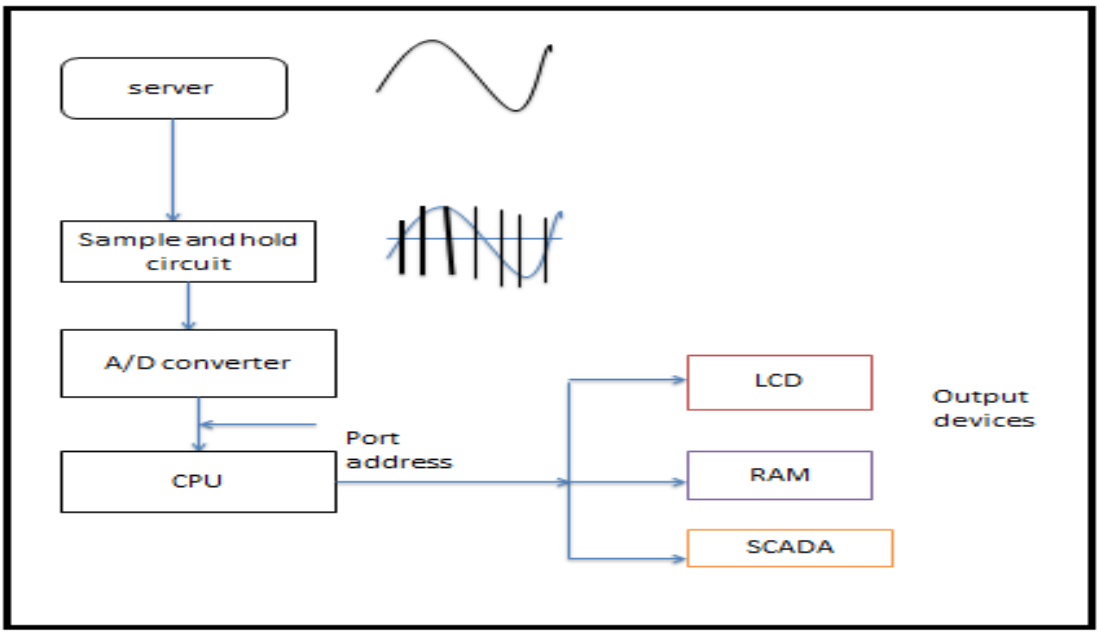

Figure 4: Sampling Process

Sampled and held value is passed to the ADC through multiplexer. The multiplexer (MUX) can be functionally compared to the operation of a selector switch. Under control of the microprocessor, the multiplexer will sequentially connect the output to each of the inputs, one at a time. The incoming digital values are stored in RAM of the microprocessor. The microprocessor, along with its associated peripheral circuits, which performs all control, computation, self-test and communication functions.

AVAILABILITY BASEDTARIFF METERING

Generating plants generates power based on a schedule which is determined and communicated by Load Dispatch Centers (LDC). LDC coordinates generation and distribution. Generating stations and distribution companies are required to follow schedule to ensure discipline of grid. There are penalties for deviating from limits of scheduled generation and demand. To maintain grid discipline, Central Electricity Regulatory Commission (CERC) has introduced Availability based tariff (ABT) mechanism, based on the financial principals, wherein all the central sector generators and beneficiaries must declare a schedule for dispatch and drawl for every 15 minutes one day in advance. Any deviation from the schedule is charged as penalty.ABT meter is smart meter which notifies change in frequency in realtime. following diagram shows ABT metering for state electricity utility [7]

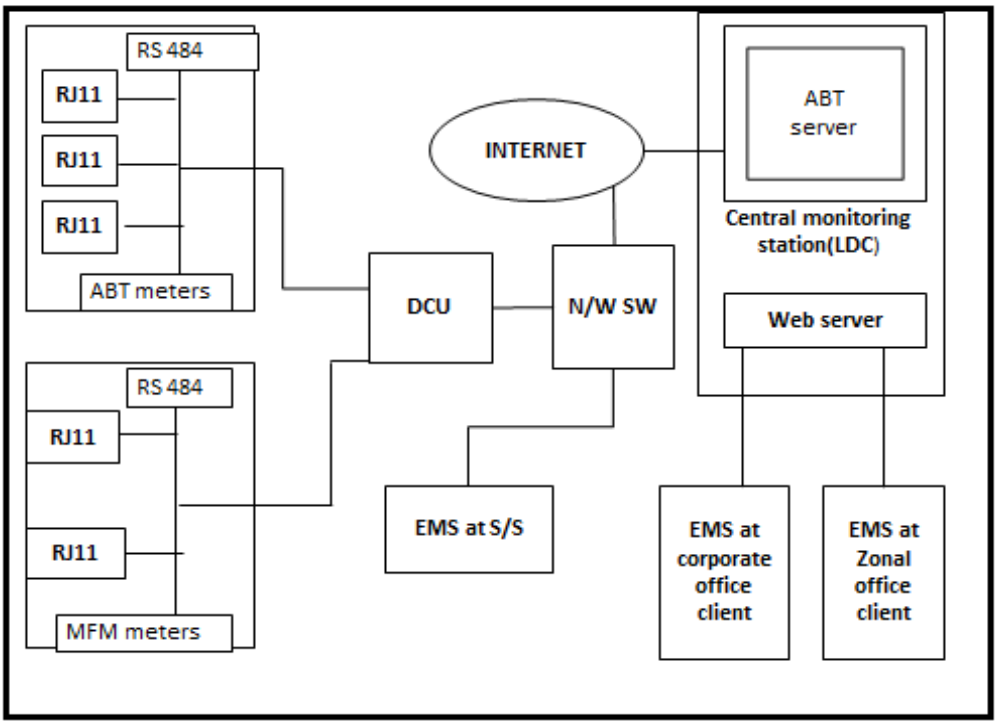

Figure 5: Availability Based Tariff metering

CLIENT-SERVER COMMUNICATION

Android based communication is drawing attention now days in smart grid environment because of use of GSM technology and its real time interactivity.[5] It is based on client server communication. It is having advantages like power saving, less network data consumption, high speed of data process and the correctness of the packages.

Requirement of communication

- Protocol TCP/IP
- IP address of client
- IP address of server
- Port no of client
- Port no of server

To initiate client server connection, the transmission control protocol is used.TCP is reliable protocol. It guarantees the delivery of the data it transmits. If packets are lost or damaged TCP will resend the data until it verifies that packets have been successfully transmitted.

Once the communication is established the client and server both read from and write to the socket when communicating. Internet Protocol (IP) is a subpart of TCP/IP protocol. TCP/IP protocol provides service to transfer data from one network device to another using internet.TCP/IP consist of five layers- physical, data link, network, transport and application. These layers consist of various supporting layers. Internet protocol belongs to the network and provides connectionless delivery of packets through an internetwork.

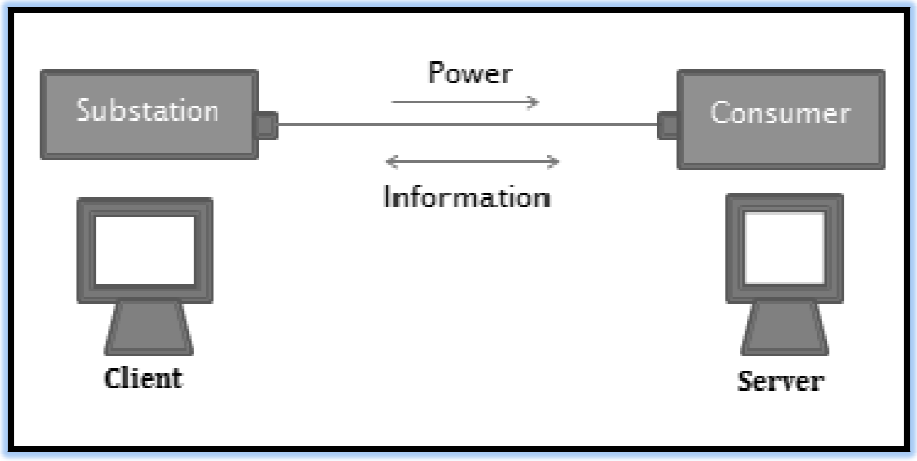

Figure 6: Information and Power Flow between Client and Server

Following table represents real time smart meter data collected from Chinchwad Substation, Pune. Considering client server communication. Consumer will be client having Android phone and substation meter is server having real time information of feeder data.

Table 1: Data Collected From Smart Meter

Name of Feeder	Amp	Voltage	MW	MVR	Pf
Chakan 220Kv	279.16	240.136	111.417	20.997	0.983
Telco	154.76	240.138	52.940	36.794	0.821
Hinjewadi-1	172.25	240.164	-70.979	2.069	-1.00
urse	198.91	240.144	64.674	-52.786	-0.775
Parvati	83.11	240.084	-31.163	-8.676	0.963
Flagship	134.00	240.342	54.72	5.259	0.995
Bajaj Auto	75.59	140.351	-15.975	9.399	-0.862

FLOW CHART OF CLIENT SERVER COMMUNICATION

Server remains in wait state till the request comes from client. Android client and server will use persistent socket mechanism for establishment of communication. Server pushes the messages to Android client; client can send messages to server. Client will check all the time whether server is alive or not. This method gives efficient data transfer and lightweight data packets will consume less space.

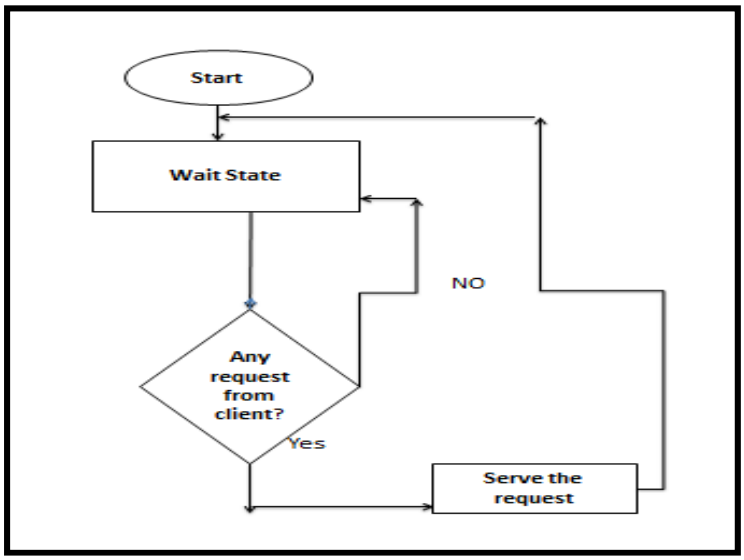

Figure 7: Client Server Communication Flowchart

Algorithm

Find IP address and protocol number of the server

Allocate a command for socket

- Specify that the connection needs protocol port on local machine
- Connect the socket to the server
- Communicate with the server using application level protocol
- Close the connection

The algorithm is explained through Java psudocode

Import java.io.*;// client server communication

Public class main

{

Public static void main (string []args) throws IO Exception

{FileInputStream fis=new FileInputStream (“file1.text);

DataInputStream dis=new DataInputstream (fis);

FileOutputStream fos= new FileOutputStream (“text2.text)

```
DataOutputStream dis=new DataOutputStream (fos);

String mtrdata= dis.readLine();

System.out.println("print meter data" + mtrdata );

Dos.writeBytes(mtrdata);

}

}
```

CONCLUSIONS

By incorporating AMI into the conventional grid, we get benefited by effective two way communication between the user and the utility, and improved energy efficiency [8]. AMI with android platform provides real time data, remote monitoring and information about any equipment failure in the system, natural accidents etc, through a proactive approach. In this paper, smart meter, which is a key component of AMI, is described in detail. Different layers of TCP/IP protocol are presented. There is wide scope for the research in the area of smart meters and communication. Future work will include an addition of some display parameters of the smart meters and intimation of those parameters on mobile using android platform.

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REFERENCES

1. *Zhang Luhua,Yi Zhonglin,Yuan Ruiming,Zhou Hui,Yin Qingduo "Effects of Advanced metering Infrastructure on Relations of power supply and Application in smart Grid," IEEE 2010.*
2. *Hahn Tram, "Technical and operation considerations in Using smart metering for outage management", IEEE 2008.*
3. *Y. G. Paithankar S. R. Bhide "Fundamental of power system protection"*
4. *Dr.S.M.Bakre,,Nakul Bakre "Object Oriented Approach for Sensing Measurement Communication and Control of Data using Numeric Meters", March 2012*
5. *Zhilong Yang, YongWnag, Yongquan yang, Zhiqiang Wei "Research and Design of a Real time Interactive application development model based on the android Platform", IEEE 2013*
6. *Computer Networks, "Andrew S. Tanenbaum"*
7. *Velhal, G. ; Pujara, A. ; Bakre, S.M. ; Muralidhara, V.On progress of communication infrastructure for fault location and ABT metering,IEEE 2014*
8. *Avani Pujara , Geeta Velhal , Dr S.M.Bakre , Dr V.Muralidhara, A Review on Smart Grid in India, International journal of innovative research in electrical, electronics, instrumentation and control engineering, Vol. 3, Issue 3, March 2015*